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DEPT. OF TRANSPORTATION  
NHTSA

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SUBJECT: Test Matrix for High Speed and Endurance tests

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NHTSA

TO: Docket NHTSA-2000-8011-1  
FMVSS 109 Tire Testing

The attached Tire Test Matrix represents the test plan of the National Highway Traffic Safety Administration (NHTSA) in its effort to evaluate the high speed and endurance performance of current passenger car (P-metric) and light truck (LT) tires. The data acquired from this testing will be used to support the agency's rulemaking proposal to upgrade Federal Motor Vehicle Safety Standard No. 109.

The Test Matrix is preliminary and may change as the agency negotiates a final test agreement with the test laboratory that will be awarded the contract to conduct the testing.

TIRE RESEARCH  
HIGH SPEED TEST MATRIX  
P-METRIC TIRES

**TABLE 1**

LOAD (%)	INFLATION PRESSURE (kPa)	TEST SPEED (km/h)	DURATION (mins)	AMBIENT (deg C)	TEST TIME (hrs)
80	ECE R30 pressure	ITS, +10, +20, +30	10, 10, 10, 20	25	50 mins
80	180	ITS, +10, +20, +30	10, 10, 10, 10	38	
80	180	ITS, +10, +20, +30	20, 20, 20, 20	38	
80	180	ITS, +10, +20, +30	30, 30, 30, 30	38	4
80	210	ITS, +10, +20, +30	10, 10, 10, 10	38	
80	210	ITS, +10, +20, +30	20, 20, 20, 20	38	
80	210	ITS, +10, +20, +30	30, 30, 30, 30	38	4
80	240	ITS, +10, +20, +30	10, 10, 10, 10	38	
80	240	ITS, +10, +20, +30	20, 20, 20, 20	38	
80	240	ITS, +10, +20, +30	30, 30, 30, 30	38	4

ITS = Initial Test Speed, defined as Rated speed of tire less 30 km/h

TIRE RESEARCH  
HIGH SPEED TEST MATRIX  
P-METRIC TIRES

**TABLE 2**

LOAD (%)	INFLATION PRESSURE (kPa)	SPEED (km/h)	DURATION (mins)	AMBIENT TEST TIME (deg C)	AMBIENT TEST TIME (hrs)
90	180	ITS, +10, +20, +30	10, 10, 10, 10	38	
90	180	ITS, +10, +20, +30	20, 20, 20, 20	38	
90	180	ITS, +10, +20, +30	30, 30, 30, 30	38	4
90	210	ITS, +10, +20, +30	10, 10, 10, 10	38	
90	210	ITS, +10, +20, +30	20, 20, 20, 20	38	
90	210	ITS, +10, +20, +30	30, 30, 30, 30	38	4
90	240	ITS, +10, +20, +30	10, 10, 10, 10	38	
90	240	ITS, +10, +20, +30	20, 20, 20, 20	38	
90	240	ITS, +10, +20, +30	30, 30, 30, 30	38	4

ITS = Initial Test Speed, defined as Rated speed of tire less 30 km/h

TIRE RESEARCH  
HIGH SPEED TEST MATRIX  
P-METRIC TIRES

**TABLE 3**

LOAD (%)	INFLATION PRESSURE (kPa)	SPEED (km/h)	DURATION (mins)	AMBIENT (deg C)	TEST TIME (hrs)
100	180	ITS, +10, +20, +30	10, 10, 10, 10	38	
100	180	ITS, +10, +20, +30	20, 20, 20, 20	38	
100	180	ITS, +10, +20, +30	30, 30, 30, 30	38	4
100	210	ITS, +10, +20, +30	10, 10, 10, 10	38	
100	210	ITS, +10, +20, +30	20, 20, 20, 20	38	
100	210	ITS, +10, +20, +30	30, 30, 30, 30	38	4
100	240	ITS, +10, +20, +30	10, 10, 10, 10	38	
100	240	ITS, +10, +20, +30	20, 20, 20, 20	38	
100	240	ITS, +10, +20, +30	30, 30, 30, 30	38	4

ITS = Initial Test Speed, defined as Rated speed of tire less 30 km/h

## HIGH SPEED TEST FOR P-METRIC TIRES

### 1 Preparation of tire

Inspect the tire using a laser or x-ray machine for any production tire defects such as tread, ply or belt separations, poor adhesion and under cure.

#### 1.1 Baseline Test:

Mount the tire on a test rim and inflate it to the appropriate pressure specified in the table below (if tire has no speed symbol, and is not marked ZR in the size designation, test as if speed category Q).

ECE Regulation 30 Inflation Pressure -- kPa

Speed category	Diagonal (bias-ply) tires			Radial & bias-belted tires	
	Ply rating			Standard	Reinforced
	4	6	8		
L, M, N	230	270	300	240	280
P, Q, R, S	260	300	330	260	300
T, U, H	280	320	350	280	320
V	300	340	370	300	340
W, Y	-	-	-	320	360

1.1.1 Condition the assembly at  $25 \pm 5^{\circ}\text{C}$  for at least three (3) hours.

1.1.2 Readjust the tire pressure to that specified in paragraph 1.1 above immediately before testing.

#### 1.2 Matrix Test

Mount the tire on a test rim and inflate it to the appropriate pressure specified in the Matrix Tables 1, 2, or 3.

1.2.1 Condition the assembly at  $38 \pm 3^{\circ}\text{C}$  for at least three hours.

1.2.2 Readjust the tire inflation pressure to that specified in the Test Matrix, immediately before testing.

### 2 Test Procedure

2.1 Press the tire and wheel assembly against a flat-faced steel test wheel 1.7 meters in diameter and at least as wide as the section width of the tire to be tested.

2.2 Apply to the test axle, a load equal to 80%, 90%, or 100% of the tire's maximum load capacity. Refer to Table 1 – 80% Load, Table 2 – 90% Load, and Table 3 – 100% Load, for the corresponding test inflation pressure, duration and ambient temperature.

2.3 Break in the tire by running it for 2 hours at 80 km/h.

- 2.4 Allow the tire to cool to  $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$  for the baseline test, and  $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$  for the matrix test, and then readjust the inflation pressure to the applicable pressure in the test matrix.
- 2.5 Throughout the test the inflation pressure shall not be corrected and the test load shall be kept constant.
- 2.6 During the test the ambient temperature, at a distance of not less than 150 mm and not more than 1 m from the tire, shall be maintained at  $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$ .
- 2.7 Carry the test through without interruptions as follows, in relation to the tire's speed symbol.
- 2.8 The initial test speed (ITS) is equal to the tire's speed category (if the tire has no speed symbol or has a speed category below "T", test as if the speed category is T)
- less 30 km/h on a  $1.70\text{ m} \pm 1\%$  drum, or
- 2.8.1 Accelerate the equipment at a constant rate such that the initial test speed (ITS) is reached at the end of 10 minutes from start-up.
- then, at the ITS for 10 minutes, 20 minutes or 30 minutes, as specified in Test Matrix
  - then, at the ITS plus 10 km/h for 10 minutes, 20 minutes, or 30 minutes
  - then, at the ITS plus 20 km/h for 10 minutes, 20 minutes, or 30 minutes
  - then, at the ITS plus 30 km/h for 20 minutes for the baseline test only
  - then, at the ITS plus 30 km/h for 10 minutes, 20 minutes, or 30 minutes for Matrix test
- 2.8.2 No more than 15 minutes after running the tire for the required time, measure its inflation pressure. Allow the tire to cool for one hour. Then deflate the tire, remove it from the test rim, and inspect it.
- 2.8.3 Inspect the tire using a laser or x-ray machine that can detect evidence of belt, ply, tread, sidewall, cord, or innerliner separation, blisters, poor adhesion, cracking or open splices.

TIRE RESEARCH  
ENDURANCE TEST MATRIX  
P-METRIC TIRES

**TABLE 4**

TEST SPEED (km/h)	INFLATION PRESSURE (kPa)	LOAD (%)	DURATION (hrs)	AMBIENT (deg C)	TEST TIME (hrs)
80	180	100	4	38	
80	180	110	6	38	
80	180	115	24	38	34
120	160	100	8	38	
120	160	115	10	38	
120	160	125	32	38	50
120	200	100	8	38	
120	200	115	10	38	
120	200	125	32	38	50
TEST SPEED (km/h)	INFLATION PRESSURE (kPa)	LOAD (%)	DURATION (hrs)	AMBIENT (deg C)	TEST TIME (hrs)
140	160	100	8	38	
140	160	115	10	38	
140	160	125	32	38	50
140	200	100	8	38	
140	200	115	10	38	
140	200	125	32	38	50

## ENDURANCE TEST PROCEDURE FOR P-METRIC TIRES

### Preparation of Tire

- 1.1 Inspect the tire using a laser or x-ray machine for any production tire defects such as tread, ply or belt separations, poor adhesion and under cure.
- 1.2 Mount the tire on a test rim and inflate it to the pressure specified in the Test Matrix
- 1.3 Condition the assembly at  $35 \pm 3^{\circ}\text{C}$  for at least three hours.
- 1.4 Readjust the inflation pressure to the Test Matrix value specified immediately before testing.

### 2 Test Procedure

- 2.1 Mount the tire and wheel assembly on a test axle and press it against a flat-faced steel test wheel having a diameter of  $1.70 \text{ m} \pm 1\%$ , and at least as wide as the section width of the tire to be tested.
- 2.2 During the test the ambient temperature, at a distance of not less than 150 mm and not more than 1 m from the tire, shall be at  $38 \pm 3^{\circ}\text{C}$ .
- 2.3 Conduct the test, without interruptions, at the test speed specified in the Test Matrix with the corresponding loads and test periods as those shown in the Test Matrix.
- 2.4 Throughout the test, the inflation pressure shall not be corrected and the test loads shall be kept constant at the value corresponding to each test period.
- 2.5 No more than 15 minutes after running the tire the required time, measure its inflation pressure. Allow the tire to cool for one hour. Then deflate the tire, remove it from the test rim, and inspect it.
- 2.6 Inspect the tire using a laser or x-ray machine that can detect evidence of belt, ply, tread, sidewall, cord, or innerliner separation, blisters, poor adhesion, cracking or open splices.



TIRE RESEARCH  
HIGH SPEED TEST MATRIX  
LIGHT TRUCK TIRES

**TABLE 1**

LOAD (%)	INFLATION PRESSURE (kPa)	TEST SPEED (km/h)	DURATION (mins)	AMBIENT TEST TIME (deg C)	TEST TIME (hrs)
88	See tire sidewall label	75 mph, 80 mph, 85 mph	30, 30, 30	38	1.5
80	260	ITS, +10, +20, +30	10, 10, 10, 10	38	
80	260	ITS, +10, +20, +30	20, 20, 20, 20	38	
80	260	ITS, +10, +20, +30	30, 30, 30, 30	38	4
80	300	ITS, +10, +20, +30	10, 10, 10, 10	38	
80	300	ITS, +10, +20, +30	20, 20, 20, 20	38	
80	300	ITS, +10, +20, +30	30, 30, 30, 30	38	4
80	350	ITS, +10, +20, +30	10, 10, 10, 10	38	
80	350	ITS, +10, +20, +30	20, 20, 20, 20	38	
80	350	ITS, +10, +20, +30	30, 30, 30, 30	38	4

ITS = Initial Test Speed, defined as Rated speed of tire less 30 km/h

TIRE RESEARCH  
HIGH SPEED TEST MATRIX  
LIGHT TRUCK TIRES

**TABLE 2**

LOAD (%)	INFLATION PRESSURE (kPa)	SPEED (km/h)	DURATION (mins)	AMBIENT TEST TIME (deg C)	TEST TIME (hrs)
90	260	ITS, +10, +20, +30	10, 10, 10, 10	38	
90	260	ITS, +10, +20, +30	20, 20, 20, 20	38	
90	260	ITS, +10, +20, +30	30, 30, 30, 30	38	4
90	300	ITS, +10, +20, +30	10, 10, 10, 10	38	
90	300	ITS, +10, +20, +30	20, 20, 20, 20	38	
90	300	ITS, +10, +20, +30	30, 30, 30, 30	38	4
90	350	ITS, +10, +20, +30	10, 10, 10, 10	38	
90	350	ITS, +10, +20, +30	20, 20, 20, 20	38	
90	350	ITS, +10, +20, +30	30, 30, 30, 30	38	4

ITS = Initial Test Speed, defined as Rated speed of tire less 30 km/h

TIRE RESEARCH  
HIGH SPEED TEST MATRIX  
LIGHT TRUCK TIRES

**TABLE 3**

LOAD (%)	INFLATION PRESSURE (kPa)	SPEED (km/h)	DURATION (mins)	AMBIENT (deg C)	TEST TIME (hrs)
100	260	ITS, +10, +20, +30	10, 10, 10, 10	38	
100	260	ITS, +10, +20, +30	20, 20, 20, 20	38	
100	260	ITS, +10, +20, +30	30, 30, 30, 30	38	4
100	300	ITS, +10, +20, +30	10, 10, 10, 10	38	
100	300	ITS, +10, +20, +30	20, 20, 20, 20	38	
100	300	ITS, +10, +20, +30	30, 30, 30, 30	38	4
100	350	ITS, +10, +20, +30	10, 10, 10, 10	38	
100	350	ITS, +10, +20, +30	20, 20, 20, 20	38	
100	350	ITS, +10, +20, +30	30, 30, 30, 30	38	4

ITS = Initial Test Speed, defined as Rated speed of tire less 30 km/h

## HIGH SPEED TEST FOR LIGHT TRUCK (LT) TIRES

### 1 Preparation of tire

Inspect the tire using a laser or x-ray machine for any production tire defects such as tread, ply or belt separations, poor adhesion and under cure.

#### 1.1 Baseline Test:

Mount the tire on a test rim and inflate it to the inflation pressure specified for the maximum load rating marked on the tire. Use a single maximum load value when the tire is marked with both single and dual maximum load.

1.1.1 Condition the assembly at  $38 \pm 3^{\circ}\text{C}$  for at least three (3) hours.

1.1.2 Readjust the tire pressure to that specified in paragraph 1.1 above immediately before testing.

#### 1.2 Matrix Test

Mount the tire on a test rim and inflate it to the appropriate pressure specified in the Matrix Tables 1, 2, or 3.

1.2.1 Condition the assembly at  $38 \pm 3^{\circ}\text{C}$  for at least three hours.

1.2.2 Readjust the tire inflation pressure to that specified in the Test Matrix, immediately before testing.

### 2 Test Procedure

2.1 Press the tire and wheel assembly against a flat-faced steel test wheel 1.7 meters in diameter and at least as wide as the section width of the tire to be tested.

2.2 Apply to the test axle, a load equal to 80%, 90%, or 100% of the tire's maximum load capacity. Refer to Table 1 – 80% Load, Table 2 – 90% Load, and Table 3 – 100% Load, for the corresponding test inflation pressure, duration and ambient temperature.

2.3 Break in the tire by running it for 2 hours at 80 km/h.

2.4 Allow the tire to cool to  $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$ , and then readjust the inflation pressure to the applicable pressure in the test matrix.

2.5 Throughout the test the inflation pressure shall not be corrected and the test load shall be kept constant.

2.6 During the test the ambient temperature, at a distance of not less than 150 mm and not more than 1 m from the tire, shall be maintained at  $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$ .

2.7 Carry the test through without interruptions as follows, in relation to the tire's speed symbol.

2.8 The initial test speed (ITS) is equal to the tire's speed category (if the tire has no speed symbol or has a speed category below "T", test as if the speed category is T)  
- less 30 km/h on a  $1.70 \text{ m} \pm 1\%$  drum, or

- 2.8.1 Accelerate the equipment at a constant rate such that the initial test speed (ITS) is reached at the end of 10 minutes from start-up.
- then, at the ITS for 10 minutes, 20 minutes or 30 minutes, as specified in Test Matrix
  - then, at the ITS plus 10 km/h for 10 minutes, 20 minutes, or 30 minutes
  - then, at the ITS plus 20 km/h for 10 minutes, 20 minutes, or 30 minutes
  - then, at the ITS plus 30 km/h for 10 minutes, 20 minutes, or 30 minutes for Matrix test
- 2.8.2 No more than 15 minutes after running the tire for the required time, measure its inflation pressure. Allow the tire to cool for one hour. Then deflate the tire, remove it from the test rim, and inspect it.
- 2.8.3 Inspect the tire using a laser or x-ray machine that can detect evidence of belt, ply, tread, sidewall, cord, or innerliner separation, blisters, poor adhesion, cracking or open splices.

TIRE RESEARCH  
ENDURANCE TEST MATRIX  
LIGHT TRUCK TIRES

**TABLE 4**

TEST SPEED (km/h)	INFLATION PRESSURE (kPa)	LOAD (%)	DURATION (hrs)	AMBIENT (deg C)	TEST TIME (hrs)
80	Use sidewall pressure	75	7	38	
80	Use sidewall pressure	97	16	38	
80	Use sidewall pressure	114	24	38	47
120	240	100	8	38	
120	240	115	10	38	
120	240	125	32	38	50
120	290	100	8	38	
120	290	115	10	38	
120	290	125	32	38	50

TEST SPEED (km/h)	INFLATION PRESSURE (kPa)	LOAD (%)	DURATION (hrs)	AMBIENT (deg C)	TEST TIME (hrs)
140	240	100	8	38	
140	240	115	10	38	
140	240	125	32	38	50
140	290	100	8	38	
140	290	115	10	38	
140	290	125	32	38	50

## ENDURANCE TEST PROCEDURE FOR LIGHT TRUCK (LT) TIRES

### Preparation of Tire

- 1.1 Inspect the tire using a laser or x-ray machine for any production tire defects such as tread, ply or belt separations, poor adhesion and under cure.
- 1.2 Mount the tire on a test rim and inflate it to the pressure specified in the Test Matrix
- 1.3 Condition the assembly at  $35 \pm 3^{\circ}\text{C}$  for at least three hours.
- 1.4 Readjust the inflation pressure to the Test Matrix value specified immediately before testing.

### 2 Test Procedure

- 2.1 Mount the tire and wheel assembly on a test axle and press it against a flat-faced steel test wheel having a diameter of  $1.70 \text{ m} \pm 1\%$ , and at least as wide as the section width of the tire to be tested.
- 2.2 During the test the ambient temperature, at a distance of not less than 150 mm and not more than 1 m from the tire, shall be at  $38 \pm 3^{\circ}\text{C}$ .
- 2.3 Conduct the test, without interruptions, at the test speed specified in the Test Matrix with the corresponding loads and test periods as those shown in the Test Matrix.
- 2.4 Throughout the test, the inflation pressure shall not be corrected and the test loads shall be kept constant at the value corresponding to each test period.
- 2.5 No more than 15 minutes after running the tire the required time, measure its inflation pressure. Allow the tire to cool for one hour. Then deflate the tire, remove it from the test rim, and inspect it.
- 2.6 Inspect the tire using a laser or x-ray machine that can detect evidence of belt, ply, tread, sidewall, cord, or innerliner separation, blisters, poor adhesion, cracking or open splices.